A Comparison of the Ammocoete and Macrophthalmia Stages of *Mordacia mordax* and *Geotria australis* (Petromyzonidae)

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VERY LITTLE IS KNOWN of the biology of the lampreys of the Southern Hemisphere. On the available evidence (Strahan, 1959), there appears to be only one species of *Geotria, G. australis* Gray 1851, extending from Western Australia eastwards to the Falkland Islands. Almost nothing is known of its distribution while in the marine stage of its life history. The northern limits of its distribution in estuaries and rivers appear to be 32° S. on the west coast of Australia and 37° S. on the east coast of Australia and the North Island of New Zealand; 40° S. on the west coast of South America and 35° S. on the east coast. It extends southwards to Tasmania, the South Island of New Zealand, and Tierra del Fuego.

Three species of *Mordacia* have been described. *M. mordax* (Richards) 1846 has a north–south distribution similar to that of *Geotria australis* but is restricted to the Pacific coasts of Australia (where it extends northwards to about 34° S.) and of South America. The other two species, *Mordacia lapicida* (Gray) 1851 and *M. acutidens* (Philippi) 1863, are apparently restricted to the Pacific coast of South America (Plate, 1902; Lahille, 1915; Holly, 1933; Mann, 1954).

In the course of the past century, *Geotria australis* was divided into as many as seven genera and nine species. This seems to have been due partly to enthusiastic "splitting," but more to ignorance of the life history of the species, which is now known to comprise well-marked ammocoete, "macrophthalmia," "velasia," and adult stages (Maskell, 1929; Strahan, 1959). In the almost complete absence of information on the life history of any species of *Mordacia,* the possibility arises that a similar confusion exists here. Mann (1954) has suggested that the Chilean forms described as *Mordacia* are the late developmental stages of *Geotria,* but this is unlikely since the dentition of *Mordacia* is very characteristic, it being the only lamprey with two supraoral laminae on the buccal funnel. Certainly the situation cannot be clarified until more is known of the development of *Mordacia.*

Maskell (1932) stated that the ammocoete of *Mordacia* has one intestinal (exocrine pancreatic) diverticulum on the left side of the oesophagus, and can thereby be distinguished from the ammocoete of *Geotria,* which has both right and left diverticula, and from the ammocoete of Petromyzon, which has no diverticula. However, the question arises: How did Maskell know that the ammocoetes with only one diverticulum were referable to *Mordacia?* The only author to comment upon the external appearance of *Mordacia* ammocoetes was Ogilby (1896), who stated that the dorsal and caudal fins are continuous in the ammocoete but separate in the adult. This is also characteristic of *Geotria.* Some of Maskell's *Mordacia* ammocoetes were obtained from the Australian Museum, Sydney, N.S.W. Since they were demonstrably not *Geotria,* they could have belonged only to *M. mordax* or, rather improbably, to some undescribed Australian lamprey. Others were obtained from the British Museum (Natural History), London, and their place of collection is not recorded. It is probably fortuitous that these were correctly identified. Conclusive proof of identity depends upon establishing a series of intermediate stages between the ammocoete and identifiable postmetamorphic individuals.

DESCRIPTION OF MACROPHTHALMIA OF *M. mordax*

The author had the good fortune recently, while revising the British Museum collection of lampreys from the Southern Hemisphere, to find

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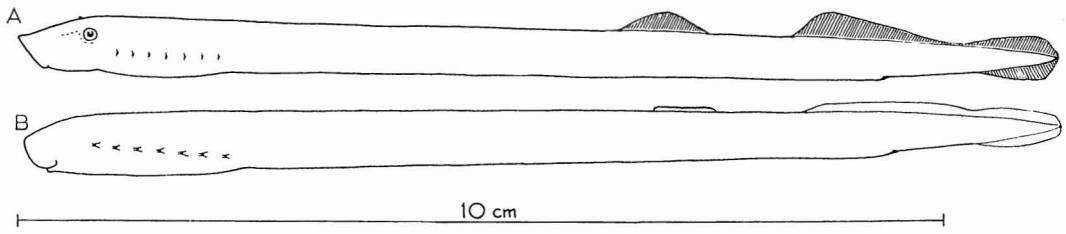

FIG. 1. *A*, Macrophthalmia stage; *B*, Ammocoete of *Mordacia mordax*.

a jar of ammocoetes labelled, "*Geotria,* 1925, from Sydney, N.S.W." For want of better knowledge, this diagnosis might have been accepted, had the jar not also contained a macrophthalmia (a large-eyed, recently-metamorphosed stage) which was markedly different from the macrophthalmia of *G. australis.* It possessed two tricuspid supraoral laminae which showed it to be a *Mordacia,* and three conical teeth anterior to the supraoral lamina and separating the rows of lateral tooth plates, which identified it as *M. mordax.* This stage in the life history of the species has not previously been recorded or described.

The specimen, which is preserved in alcohol, is of a uniformly pale yellowish-brown colour, as are the ammocoetes with it. The body is laterally compressed, much more so than in an ammocoete of the same length. It is 122 mm. long, being about 2 cm. shorter than the largest ammocoete in the sample. The eye is large and prominent and the iris has a silvery sheen. Measuring from the anterior tip of the head, the nasal aperture lies at 6 mm. and the centre of the eye at 7 mm. Eight lateral line pits form an infraorbital series and no other lateral line organs are discernible. The branchial region extends from 12 mm. to 22 mm. The first dorsal fin arises at 70 mm. and extends to 76.5 mm.; the second dorsal fin extends from 88 mm. to 108.5 mm. and is contiguous with the caudal fin. All the fins have distinct fin rays and are rather triangular in profile, differing from the fins of the ammocoete, which take the form of a low quadrilateral. The anterior border of the cloacal aperture lies 102 mm. from the anterior end of the body (Fig. 1*A*).

The mouth aperture is oval in shape, being longer longitudinally than transversely (Fig. 2). When opened to its full extent, its diameter is less than the diameter of the body. The mouth is surrounded, except posteriorly, by small, bluntly conical cirri lying just outside the rim of the buccal funnel. Just within the rim is a complete series of small, flat, fringed processes lying closely side by side. Two large supraoral tooth plates lie just anterior to the centre of the buccal funnel, separated from each other by a distance equal to the width of a tooth plate. Each tooth plate bears three sharp-pointed cusps which are directed posteriorly. From the shape of the tooth plates, it appears that each tricuspid plate may have arisen by the fusion of three unicuspid elements. Anterior to the supraoral tooth plates and in the mid-line are three small unicuspid teeth arranged in a triangle with the apex pointing anteriorly. On the right and on the left side of the buccal cavity is a series of five small bicuspid lateral tooth plates arranged radially. Posteriorly, external to the infraoral lamina, is a series of eight bicuspid tooth plates, also having a radial orientation. The infraoral lamina bears nine low, pointed cusps, the penultimate of these at each end being slightly higher than the others. The anterior lingual tooth plate has a finely serrated edge. The two posterior lingual tooth plates cannot be seen very well in the specimen.

COMPARISON OF MACROPHTHALMIA STAGES OF *G. australis* AND *M. mordax*

The macrophthalmia of *G. australis* has been described by Maskell (1929) and it is unnecessary to repeat the description here. Table 1 summarizes the differences between the macrophthalmia stages of the two species.

Apart from the dentition, which alone is sufficient to separate the macrophthalmia stages of

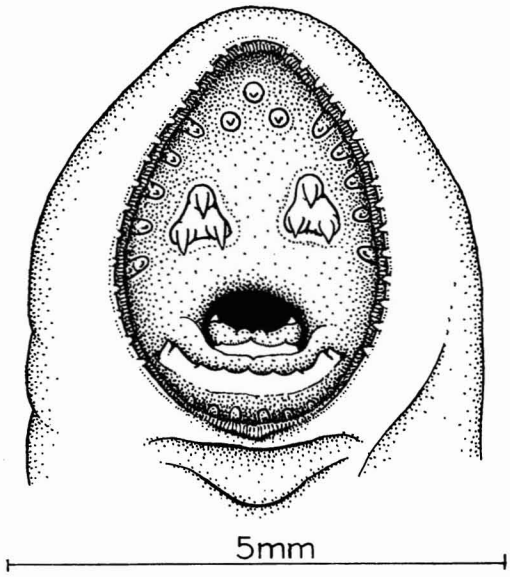

FIG. 2. Ventral view of head of macrophthalmia of *Mordacia mordax.*

the two species, another striking difference between them is the more posterior position of the cloacal aperture in *M. mordax.* This is expressible in relation to the total length of the body, in relation to the anterior border of the second dorsal fin, or in the number of precloacal myomeres.

COMPARISON OF AMMOCOETES OF *G. australis* AND *M. mordax*

It was possible that the *Mordacia* macrophthalmia had been accidentally included in a sample of *Geotria* ammocoetes, but examination of these showed that in the position of the cloaca they closely resembled the *Mordacia* specimen and differed from known ammocoetes of *Geotria* (Table 2). Dissection of several of the ammocoetes revealed that each possessed only one intestinal diverticulum, thus confirming Maskell's original observation. Figure 1*B* shows the body proportions of an ammocoete 123 mm. long.

DISCUSSION

It is unfortunate that the sample of *Mordacia* ammocoetes contained no smaller specimens which could be compared with small specimens of *Geotria.* However, the great uniformity in proportions over the length range, 100–160 mm., suggests that smaller ammocoetes of *M. mordax* would also be distinguishable by the position of the cloaca. In adult specimens of *Mordacia* the cloaca is found at 83–84 per cent of the length of the body, there being no difference in this respect between *M. mordax, M. lapicida,* or *M. acutidens* specimens in the British Museum. In the velasia stage of *G. australis* the cloaca occupies almost the same position as in the macrophthalmia and the ammocoete. Eleven unpouched specimens had the cloaca at 77 ± 1 per cent of the total length. However, the resorption of the tail tissues, consequent upon the cessation of feeding in the adults, causes a relative backward shift in the position of the cloaca and the first dorsal fin. In 11 pouched adults, these occurred at 79 ± 3 per cent of the total length.

TABLE 1

COMPARISON OF MACROPHTHALMIA STAGES OF *Mordacia mordax* AND *Geotria australis,* BASED ON ONE SPECIMEN OF *M. mordax* AND SIX SPECIMENS OF *G. australis*
(Standard deviations calculated for all means)

	M. mordax	*G. australis*
Total length (T. L.)	122 mm.	103 ± 5 mm.
Tip of head to origin of first dorsal fin	57% of T. L.	58 ± 1% of T. L.
Tip of head to origin of second dorsal fin	72% of T. L.	76 ± 1% of T. L.
Tip of head to anterior border of cloaca	83% of T. L.	76 ± 1% of T. L.
Number of precloacal myomeres	102	93 ± 2
Supraoral lamina	two, each with 3 cusps	one, with 4 cusps
Pair of enlarged lateral buccal cirri	absent	present
Coloured dorsal stripes	absent*	present

* The skin of this specimen is very similar to that of an ammocoete, having no metallic lustre. It is possible that the specimen is incompletely metamorphosed in this respect or that the specimen became decolourized by preservation.

TABLE 2

POSITION OF THE CLOACA IN AMMOCOETES OF *Mordacia mordax* AND *Geotria australis*

M. mordax				*G. australis*			
Total length (mm.)	Head to cloaca		No. of precloacal myomeres	Total length (mm.)	Head to cloaca		No. of precloacal myomeres
	mm.	% of T. L.			mm.	% of T. L.	
102	84	82	104	37	29	78	92
111	93	84	103	44	35	80	90
121	101	83	102	52	41	79	91
130	109	84	103	55	44	80	90
131	111	85	101	61	50	82	93
132	110	83	101	73	57	78	89
135	113	84	103	83	64	77	91
140	118	84	103	84	64	76	95
145	120	83	102	87	67	77	90
160	135	84	103	89	68	76	92
		84 ± 1%	103 ± 1.0			78 ± 2%	91 ± 1.7

It is noteworthy that the largest ammocoete of *M. mordax* in the sample (160 mm. long) is much longer than the largest ammocoete of *Geotria* recorded by Maskell (1929) from New Zealand (104 mm. long), or by the author, from Western Australia (100 mm. long). This is the opposite condition to that of the adults. Fourteen specimens of *M. mordax* in the National Museum of Victoria, Melbourne, ranged from 21 to 42 cm. in length (average 33 ± 5 cm.), while 22 specimens of *G. australis* from the same collection ranged from 34 to 58 cm. in length (average 47 ± 7 cm.). This condition of a relatively larger larva and relatively smaller adult suggests that, compared with *Geotria, M. mordax* has a tendency to neoteny.

SUMMARY

A single macrophthalmia stage of *Mordacia mordax* is described. Its dentition is very similar to that of the adult and thus is different from that of *Geotria australis.*

Although in general body form the ammocoetes and the macrophthalmia stages of the two species are very similar, the cloaca is more posterior in *Mordacia,* lying at 84 ± 1 per cent of the total length of the body, well behind the origin of the second dorsal fin, and with 103 ± 1 precloacal myomeres. *Geotria* has the cloaca at 78 ± 2 per cent of the total length, just below the origin of the second dorsal fin, and with 91 ± 1.7 precloacal myomeres. This character serves to distinguish premetamorphic stages of the two Australian species. It is also relatively constant in older stages, except in the secondarily shortened mature adults of *Geotria.*

The ammocoetes of *M. mordax* grow to a greater length than those of *G. australis,* whereas the adults are shorter. This suggests a relative tendency towards neoteny in *M. mordax.*

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